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Host preference and digestibility indices of *Spodoptera litura* (Fab.) on different host plants under laboratory condition

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Abstract
The present studies were undertaken at Department of Entomology, College of Agriculture, Dapoli (M.S.) during 2017-18 to study the host preference and digestibility indices of *Spodoptera litura* (Fab.) on different host plants under laboratory condition. The data on digestibility indices of *S. litura* on different hosts revealed that, efficiency of conversion of ingested food (ECI), Efficiency of conversion of digested food (ECD), Consumption rate (CR) and Relative growth rate (RGR) were found to be maximum on the Castor (21.82%, 23.14%, 0.92 and 3.51, respectively). The ECI and ECD were found minimum on Taro *i.e.* 12.59 and 12.71 per cent, respectively. AD was highest on Taro (98.82%) and lowest on Castor (95.01%). The mean CI value was highest on Taro (5.67) and lowest on Groundnut (3.89). The best host of *S. litura* in laboratory was castor. Tapioca and cowpea were worst and other hosts were intermediate host.

Keywords: host preference, digestibility indices, *Spodoptera litura* (Fab.) etc

Introduction
Host plant is a key determinant of the establishment, growth, survival and fecundity of herbivorous insects. Though many host plants were reported for *S. litura,* every host does not support the pest in the same way. There has been a number of studies on the biological parameters of S. *litura* on different host plants under different environmental conditions, particularly, in India (Patel *et al.*1986) [15], Pakistan (Ahmad *et al.*, 2007) [1], China (Zhu *et al.* 2000) [23] Korea (Bae and Park, 1999)[2] and other Asian countries (Etman and Hooper, 1979) [7] where S. *litura* has been an important pest on various crops.

The *Spodoptera litura* Fab. (Lepidoptera : Noctuidae) is a serious polyphagous insect causing immense damage to field crops like vegetables, oilseeds, pulses, throughout the Country (Gargav and Katiyar, 1971) [8]. This insect has been reported causing extensive damage to a wide range of crops such as oilseeds, pulses, fodders, fiber crops, fruit trees, weeds, medicinal and ornamental plants. (Singh and Singh, 1993) [18]. It was found to cause 26-100 per cent yield loss in groundnut (Dhir *et al*. 1992) [6].

Number of crops have been reported as its host plants such as maize, lentil, green gram, moth bean, castor, sesame, groundnut, tomato, cauliflower, cabbage, colocasia, agathi, indigo, slender pigweed, brinjal, chilli, banana, Lucerne, carpet weed, elephant yam, tobacco and grasses by some researchers and workers. (Lal and Nayak, 1963, Bhalani and Talati, 1984 and Bhalani, 1989) [13, 3, 4].

The objective of this study was to determine the best host that support the development of *S. litura* and can be used for mass rearing of *S. litura*. Similarly, the information of life history parameters of *S. litura* on different host plant species will help to make efficient strategies to control this economic pest (Greenberg *et al.* 2001) [10]. Moreover, evaluation of the effectiveness and efficiency of control technology require the presence of the appropriate stage, quantity and quality of insect. Therefore, mass breeding technology using high quality of feed, easy to get, and affordable is needed in order to provide insect described as above. Even though this pest feed on various crops, the differences in morphological and chemical substance between host plants may likely interfere in the biology and behavior of pest. Therefore, the present study was carried out to find out suitable host and digestibility indices of *Spodoptera litura* (Fab.) on different host plants under laboratory condition.

Materials and Methods

1. Mass rearing of *S. litura*

The larvae of *S. litura* were initially collected from the infested plants of *Palak* (*Spinacea oleracea* L.) leaves growing at the Horticulture farm of College of Agriculture, Dapoli (Maharashtra). Culture was maintained under laboratory conditions on castor *(Ricinus communis* L.) leaves at room temperature (27 ± 3°C) and relative humidity (70 ± 5%). Fresh food was provided daily, during experimental period. Proper hygienic conditions were maintained. Full-grown larvae were allowed to pupate in the glass bottles (18 cm height and 9 cm diameter). Pupae were separated and kept in a separate glass bottle. Emerging moths were used to build up subsequent culture. Adults were fed on 10 per cent honey. A folded black paper sheet was placed in the jar to provide suitable sites for Oviposition. Open end of bottle was covered with muslin cloth held tightly with the help of a rubber band. Eggs obtained from these moths were placed in glass bottle by cutting the paper strips along with the eggs. Newly hatched larvae were further used for different aspects of the study.

2. Experimental details

A statistically designed lab experiment using Completely Randomized Design (CRD) having replications and treatments was laid out at Department of Entomology laboratory, College of Agriculture, Dapoli to study the host preference and digestibility indices of *Spodoptera litura* (Fab.) on different host plants under laboratory condition. The details of experiment are given below:

Experimental details

Location: Department of Entomology laboratory, College of Agriculture, Dapoli.

Design: CRD

Replication: Three

No. of larvae per replication: Ten

Treatment: Eight (Different host plants as given below)

Treatments	Host plants
T_1	Castor, *Recinus communis* (L.)
T_2	Mulberry, *Morus alba* (L.)
T_3	Okra, *Abelmoschus esculentus* (L.)
T_4	Cowpea *Vigna unguiculata* (L.)
T_5	Taro, *Colocacia esculenta* (L.)
T_6	Tapioca, *Manihot esculenta (*L.)
T_7	Groundnut, *Arachis hypogaea* (L.)
T_8	Sweet potato, *Ipomoea batatas* (L.)

Study the digestibility indices of *S. litura* on different hosts

Previously starved (24 hrs.) third instar larvae from mass culture of *S. litura* were taken to insure an empty intestine. Single larva of uniform weight was placed in each plastic cup (5 cm height and 9 cm diameter); such ten cups of each treatment replicated thrice were maintained. Fresh leaves of respective host with known weight were kept in plastic cups; with individual larva of equal weight. No fresh food was provided for three days. After three days, weight of individual larva, weight of remaining food, and weight of dry excreta were taken on electronic balance to determine digestibility indices of *S. litura.*

Indices used for calculation and analysis

Various indices of food consumption and utilization were calculated as proposed by Waldbauer (1968) [20]. Indices used for calculating consumption and utilization of food by *S. litura* larva in different hosts are as follow:

$$\text{A. Consumption Index (CI)} = \frac{\text{Weight of food consumed (g)}}{\text{Duration of feeding period (Days)}} \text{ X } \frac{\text{Mean larval weight}}{\text{during feeding period (g)}}$$

$$\text{Mean larval weight During feeding period (g)} = \frac{\text{Initial weight of larvae (g) + Final weight of larvae (g)}}{\text{Duration of feeding period (Days)}}$$

$$\text{B. Growth Rate (GR)} = \frac{\text{Final weight of larvae (g) - Initial weight of larvae (g)}}{\text{Initial weight of larvae (g) X Duration of feeding period (Days)}}$$

$$\text{C. Approximate (AD) Digestibility} = \frac{\text{Weight of food consumed (g) -Weight of dry feces (g)}}{\text{Weight of food consumed (g)}} \text{ X } 100$$

$$\text{D. Consumption Rate (CR)} = \frac{\text{Weight of food consumed (g)}}{\text{Duration of feeding period (Days)}}$$

$$\text{E. Efficient Conversion Of Ingested food Into body matter (ECI \%)} = \frac{\text{Weight gained by larvae (g) during feeding period.}}{\text{Weight of food consumed (g)}} \text{ X } 100$$

[Weight gain = Final weight of larvae (g) – Initial weight of larvae (g)]

$$\text{F. Efficient Conversion Of Digested food Into body matter (ECD \%)} = \frac{\text{Weight gained by larvae (g) during feeding period}}{\text{Weight of food consumed (g) - Weight of dry excreta (g)}} \text{ X100}$$

All the data which are obtained during experimental work have been analyzed statistically.

Results and Discussion

1. Study the host preference of *S. litura* on different host plants

1.1 Performance of *Spodoptera litura* on different host plants

In this study, initially uniform weight (0.05g) third instar larvae of *S. litura* were released on respective host with known quantity of leaves as food (5gm each). After three days of continuous feeding, performance of *S. litura* in respect to weight gain, total amount of food consumed, remaining food and excreta weight (dry) was evaluated. The data in respect to above parameters are presented in Table 1.

Table 1: Performance of *S. litura* on different host plants

Host Plants	Final Weight of Larvae (g)	Remaining Food (g)	Consumed Food (g)	Excreta Dry Weight (g)
Castor	0.58	2.24	2.77	0.14
cowpea	0.18	4.07	1.00	0.02
Mulberry	0.26	3.54	1.53	0.02
Okra	0.35	3.19	1.83	0.03
Sweet potato	0.40	2.92	2.33	0.09
Taro	0.27	3.37	1.70	0.02
Groundnut	0.32	3.68	1.40	0.05
Tapioca	0.20	4.10	0.97	0.02
S.E±	0.40	0.07	0.11	0.01
CD (5%)	0.27	0.22	0.33	0.02

1.1.1 Weight gain by larvae

The data recorded in Table 1 revealed that maximum weight of the larvae was observed on castor after 3 days post feeding (0.58g). This was followed by sweet potato (0.40g) okra (0.35g) which, were at par. Further, groundnut (0.32g), taro (0.27g) and mulberry (0.26g) were also at par. The lowest weight gain was reported in tapioca and cowpea with 0.20 and 0.18 g, respectively.

Present findings are in conformity with those of Yadav *et al.* (2015) [22] who reported weight gained by the larvae of *H. armigera* on carnation (0.62g), cowpea (0.36g), capsule of castor (0.20g) and on tomato (0.92g).

1.1.2 Weight of Consumed food

The data in Table 1 revealed that maximum host consumption was reported in castor (2.77g) which was followed by sweet potato (2.33g). Next hosts to follow were okra (1.83g), taro (1.70g) and mulberry (1.53g) which, were found at par. Lowest host consumption was revealed in cow pea (1.0g) and tapioca (0.97g). From these results it was also revealed that *S. litura* larvae preferred caster and sweet potato as most preferred host and cow pea and tapioca as least preferred hosts.

Silva *et al.* (2017) [16] reported weight of consumed food by *S. frugiperda* on soybean to be (497.63 mg), cotton (720.62 mg), maize (462.19 mg) and oat (745.15 mg). Thus, the present findings are also in line with the findings of these workers.

1.1.3 Weight of dry Excreta

The data in Table 1 indicated that the highest excreta dry weight was recorded in castor (0.14g) followed by sweet potato (0.09g). The next host groundnut (0.05g) and mulberry (0.03g) which were also at par with each other. Further, the lowest dry weights of excreta were reported in cow pea (0.02g), mulberry (0.02g), taro (0.02g) and tapioca (0.0.2g) which also were at par.

Silva *et al.* (2017) [16] also observed weight of dry excreta of *S. frugiperda* on soybean (0.13g), cotton (0.09g), maize (0.13g) and oat (0.22g).

1.2 To study the digestibility indices of *S. litura* on different host plants

Various parameters related to digestibility indices were studied with third instar larvae of uniform weight (0.05g) on eight different host plants. The results are presented and discussed as below:

1.2.1 Efficiency of Conversion of Ingested Food (ECI)

ECI value is an indication of conversion of overall ingested food into various nutrients. The data present in Table 2 and showed that there was variation in ECI among the different hosts. The mean ECI value was higher on castor (21.82%) and at par with groundnut (19.23%) followed by okra (16.08%). Further okra, sweet potato (14.56%), tapioca (14.48%), mulberry (13.21%), cowpea (12.83%) and taro (12.59%) were also at par with each other.

From the above data it was observed that the highest value of ECI on castor leaves, suggested that *Spodoptera* larvae were more efficient in the conversion of ingested food into nutrients and also weight gained by such larvae, while those reared on cowpea had the lowest value of ECI which indicated that, these larvae were apparently not as efficient in turning ingested food into nutrients.

The present observations closely match with Ghumare and Mukherjee (2003) [9] also who reported that ECI percentage varied from 10.62 on mint, 14.42 on cotton, 20.81 on cabbage and 25.71 on castor. Xue *et al.* (2010) [21] reported that ECI of *S. litura* was highest on tobacco (29.75%) followed by Chinese cabbage (17.85%), cow pea (14.04%) and sweet potato (8.34%).

1.2.2 Efficiency of Conversion of Digested Food (ECD)

The ECD measures the efficiency with which assimilated food is converted into insect biomass. Data presented in Table 2 and revealed that larvae fed on castor had maximum potential (23.14%) in the conversion of ingested food to one unit of body substance throughout three days of feeding. This was followed by groundnut (19.99%) and both were found at par. Groundnut was further at par with okra (16.67%). Further okra was at par with sweet potato (15.18%), tapioca (14.84%), mulberry (13.41%) and cowpea (13.03%). While, taro (12.71%) recorded the lowest ECD.

Table 2: Digestibility indices of *S. litura* on different host plants

Host	ECI (%)	ECD (%)	AD (%)	CR	CI	RGR
Castor	21.82 (27.82)*	23.14 (28.72)	95.01 (77.21)	0.92	4.51	3.51
Cowpea	12.83 (20.88)	13.03 (21.05)	98.35 (82.68)	0.34	5.05	0.85
Mulberry	13.21 (21.30)	13.41 (21.48)	98.65 (83.34)	0.51	5.11	1.35
Okra	16.08 (23.54)	16.67 (23.98)	97.79 (81.63)	0.61	4.43	1.98
Sweet potato	14.56 (22.18)	15.18 (22.58)	95.95 (79.95)	0.78	5.41	2.24
Taro	12.59 (22.37)	12.71 (22.66)	98.82 (81.54)	0.57	5.67	1.42
Groundnut	19.23 (26.00)	19.99 (26.56)	96.11 (78.68)	0.47	3.89	1.80
Tapioca	14.48 (22.32)	14.84 (22.61)	97.26 (80.49)	0.35	4.09	0.93

S.E±	1.2O	1.29	1.28	0.04	0.33	0.39
CD (5%)	3.6	3.87	3.81	0.11	0.98	1.17

*Figures in parenthesis are arcsine values.

From the above data castor was found to be suitable host of *Spodoptera* as far as efficiency of *Spodoptera* in conversion of digested food was concern. Groundnut and okra also showed efficiency of *Spodoptera* to convert digested food. In general, on all host plants, *Spodoptera* showed better efficiency of conversion of digested food.

Present results are in conformity with those of Khedr *et al.* (2015) [12] who observed ECD values of *S. littoralis* on soybean cultivars *i.e.* suvin (22.36%), karsh (25.34%) and G86 (28.29%). Xue *et al.* (2010) recorded ECD of *S. litura* as 24.36, 21.77, 44.00, 72. 60 per cent on Chinese cabbage, cowpea, sweet potato and tobacco, respectively. Ghumare and Mukherjee (2003) [9] also reported ECD percentage on castor leaves to be 46.96, mint 31.85 and tomato 45.93 per cent.

1.2.3 Approximate digestibility (AD)

It explains how much amount of food has been digested from the amount of food ingested. Perusal of the data in Table 2 and revealed that at par AD was on taro (98.82%) followed by mulberry (98.65%), cow pea (98.35%), okra (97.79%) and tapioca (97.26%). The minimum AD values were found on groundnut (96.11%), sweet potato (95.95%) and castor (95.01%) which all were at par with tapioca (97.26%).

Approximate digestibility (AD) is one of the main factors among nutritional indices showing nutritional value of food for insect and ability for food uptake through the stomach wall. Variations in AD values show the differences in factors such as poor nutrient value, lack of balance, higher ratio of crude fibre and lower ratio of water. Ghumare and Mukherjee (2003) [9] observed AD of *S. litura* on mint (46.85%), tomato (54.45%) and on cabbage (54.61%). Nesari *et al.* (2016) [14] recorded AD of *S. litura* on beet root cultivars such as dorothea (85.41%), rozier (70.56%) and persia (71.47%). Thus the present findings also agree with the above findings.

1.2.4 Consumption Rate (CR)

It is evident from Table 2 and that CR value was highest on castor (0.92) followed by sweet potato (0.78) and okra (0.61). Further okra was at par with taro (0.57) and mulberry (0.51). The lowest CR values were found on tapioca (0.35) which was at par with cow pea (0.34).

Consumption rate is an indication of how insects prefer a host through feeding on it. CR value of castor indicated that it was consumed at a faster rate. Singh and Byas (1975)[17] reported that the food consumption rate for fifth instar larvae of *S. litura* was 0.15, 0.33, and 0.08 on castor, tobacco and cotton, respectively.

1.2.5 Consumption Index (CI)

Observations on consumption index (CI) are presented in Table 2. The mean CI value was highest on taro (5.67) which was further at par with sweet potato (5.41), mulberry (5.11) and cowpea (5.05). Further, it also remained at par with castor (4.51) and okra (4.43). However, castor was further at par with tapioca (4.09) and groundnut (3.89).

CI value is indicative of the rate of intake relative to the mean larval weight during the feeding period. It was revealed that CI was highest on the host like taro, sweet potato, mulberry and cowpea. Tiwari *et al.* (1991) [19] reported CI value on mulberry was 0.29 in case of *S. litura* larvae. Daniel and Samiayyan (2017) [5] recorded average consumption index of *S. litura* grown on chickpea, mulberry, parthenium, chillies and castor to the extent of 3.88, 3.34, 3.26, 2.82 and 3.07, respectively. Present findings are also in accordance with Daniel and Samiayyan.

1.2.6 Relative Growth Rate (RGR)

Relative growth rate (RGR) explains how much dry matter increased in the body of insect per day per gram of body weight. It directly affects speed of development which depends on quality of food and also on some abiotic factors. It is evident from the Table 2 that significantly the RGR value was highest on castor (3.51) further remaining host like sweet potato (2.24), okra (1.98) groundnut (1.80), taro (1.42) and mulberry (1.35) were at par with each other. Okra, groundnut, taro and mulberry were also at par with tapioca (0.93) and cowpea (0.85).

It is obvious that high CR and RGR values are related to adult weight, and this weight gained could have a direct relation with ECI. The results showed similarity to the earlier findings of Kour (2011) [11] who observed RGR of *S. litura* on Chinese cabbage (0.40), cowpea (0.43), sweet potato (0.32) and tobacco (0.43). Daniel and Samiayyan (2017) [5] recorded higher growth rate when larva fed with chickpea (0.47) and the least being (0.45) in castor. However, in present findings the RGR values except for tapioca and taro were quite higher.

The overall results revealed castor as the most suitable host for overall development of *S. litura* as data on various parameters of biology and digestibilty indices of *Spodoptera* were also supportive to this statement. The next best hosts were sweet potato, okra and groundnut. Similarly cowpea, mulberry and tapioca emerged as poor hosts.

Conclusion

From the present studies, the host preference and digestibility of *Spodoptera litura* (Fab.) on different host plants is important for to know the best host that support the development of *S. litura* and can be used for mass rearing of *S. litura*. Similarly, the information of life history parameters of *S. litura* on different host plant species will help to make efficient strategies to control this economic pest. The efficiency of conversion of ingested food (ECI), Efficiency of conversion of digested food (ECD), Consumption rate (CR) and Relative growth rate (RGR) were found to be maximum on the castor (21.82%, 23.14%, 0.92 and 3.51, respectively). The best host of *S. litura* in laboratory was castor. Tapioca and cowpea were worst and other hosts were intermediate host.

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